CFD Validation Experiment of a Mach 2.5 Axisymmetric Shock-Wave/Boundary-Layer Interaction

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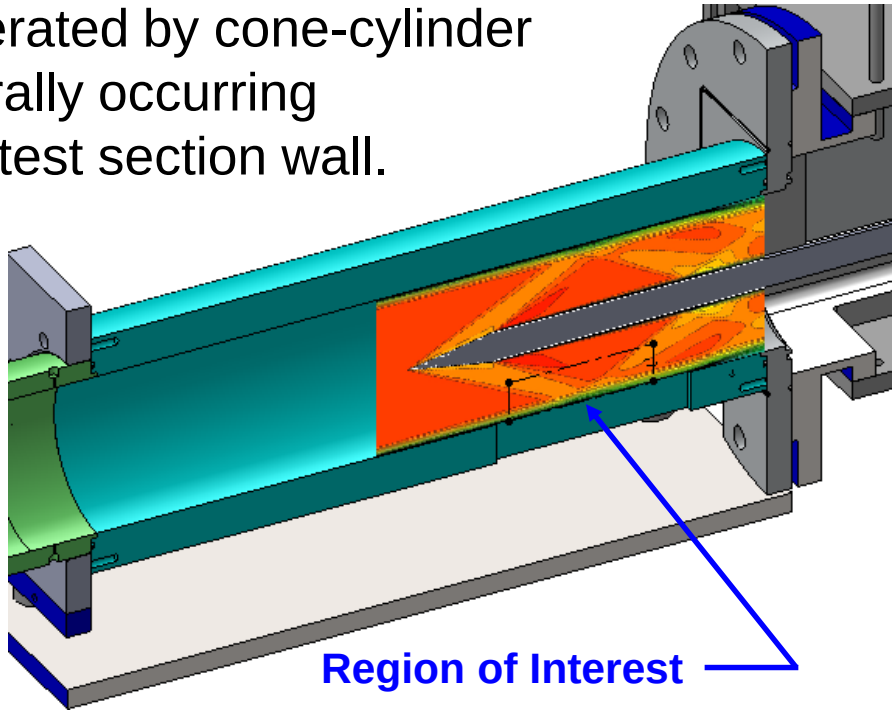
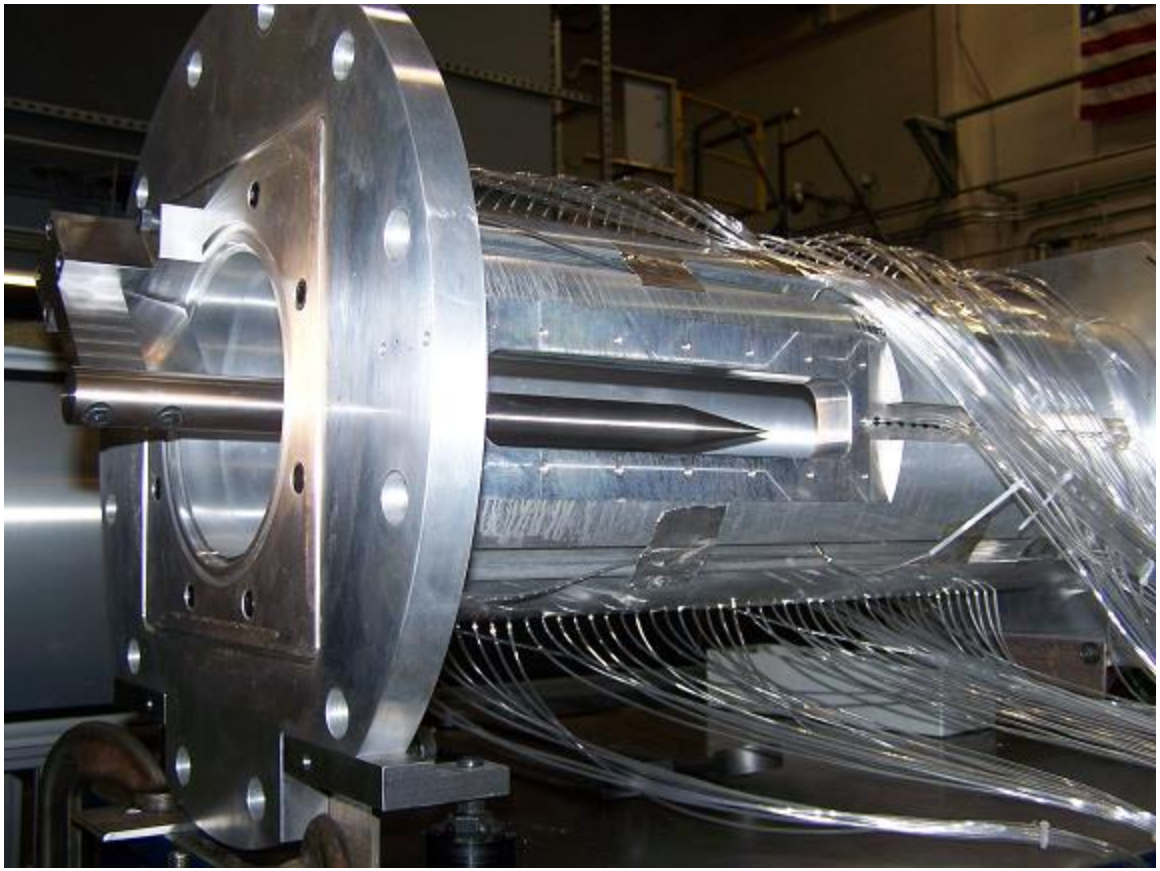
Background

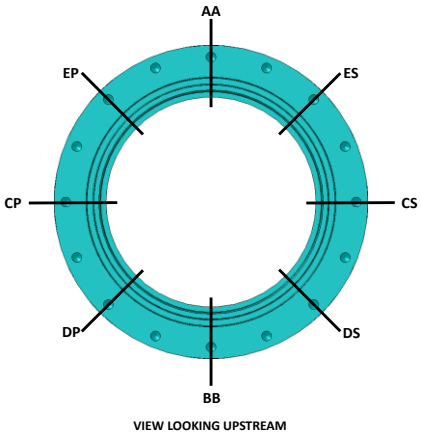
- In order to avoid the pitfalls of a rectangular configuration, an axisymmetric configuration that is two-dimensional in the mean is studied.
  - Circular test section.
  - Cone-cylinder located on the centerline.
  - Shock/expansion generated by cone-cylinder interacts with the naturally occurring boundary layer on the test section wall.

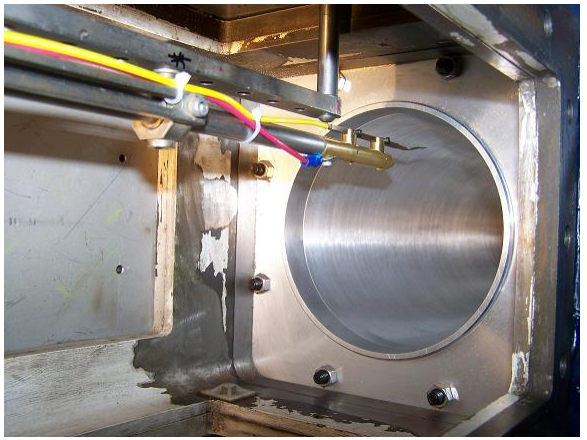


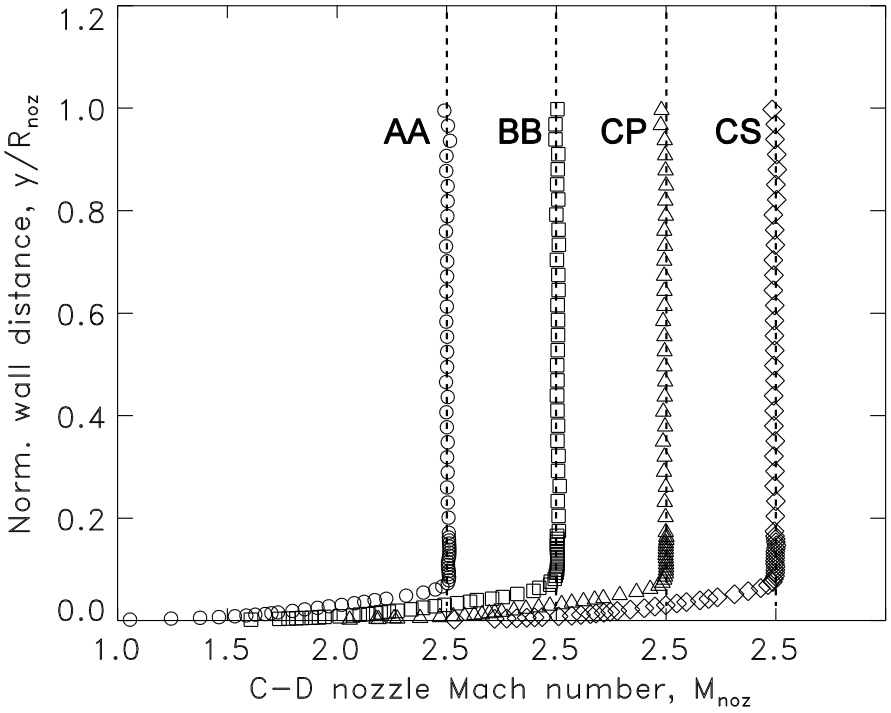
Shock Generator Assembly

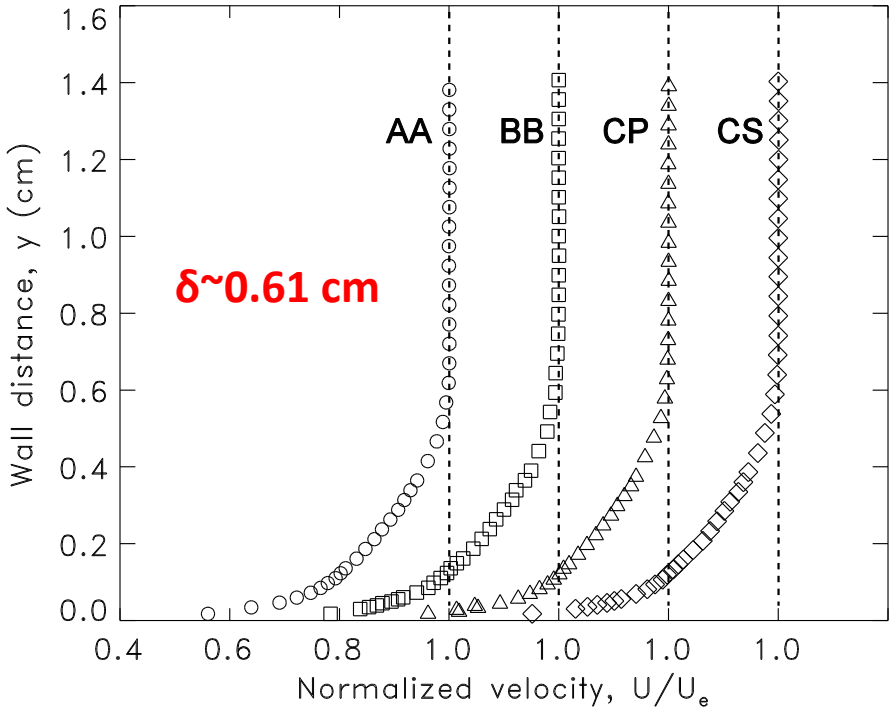


Nozzle Exit Condition

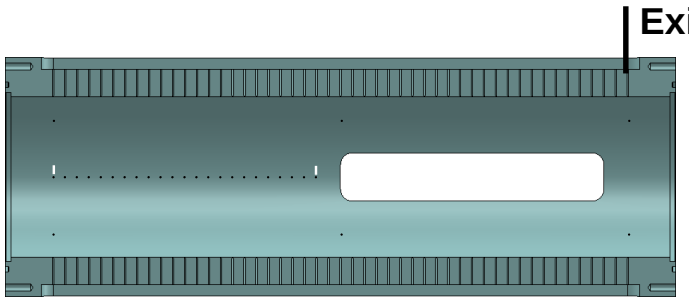




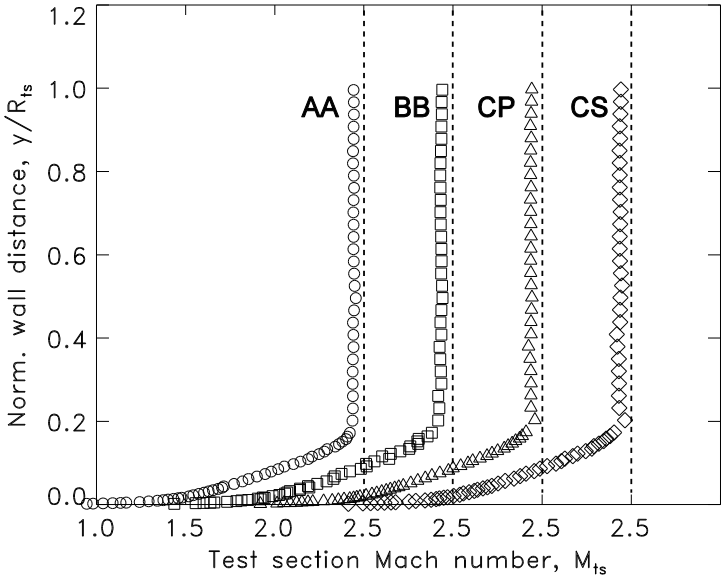


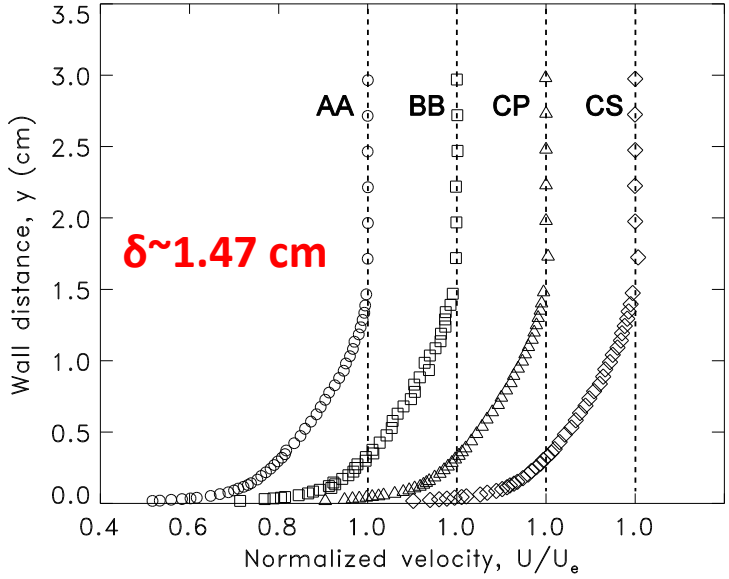


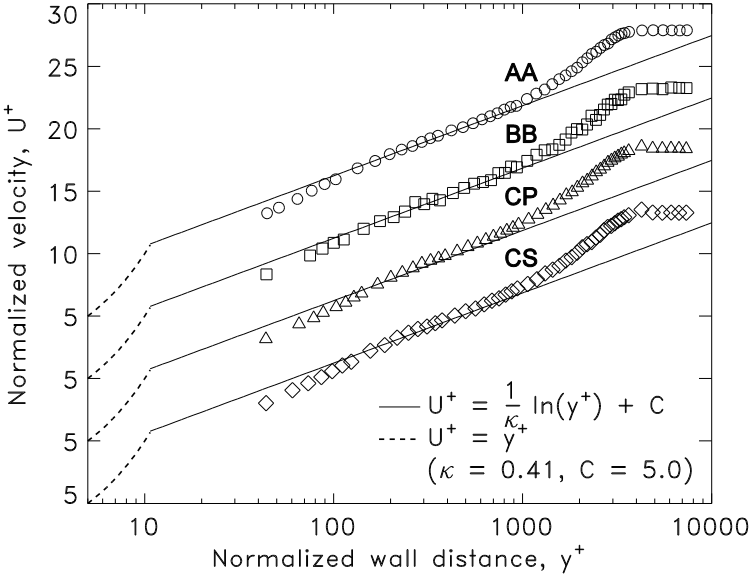
Test Section Exit Condition (x=66.0 cm)



	x (cm)	M_e	δ (cm)	δ^* (cm)	θ (cm)	H_i	C_f
WIND	-3.81	2.46	0.693	0.162	0.041	-	-
EXP	-3.81	2.50	0.608	0.161	0.041	1.39	0.00186
EXP	43.2	2.44	1.312	0.334	0.090	1.33	0.00157
EXP	66.0	2.44	1.465	0.389	0.106	1.31	0.00152



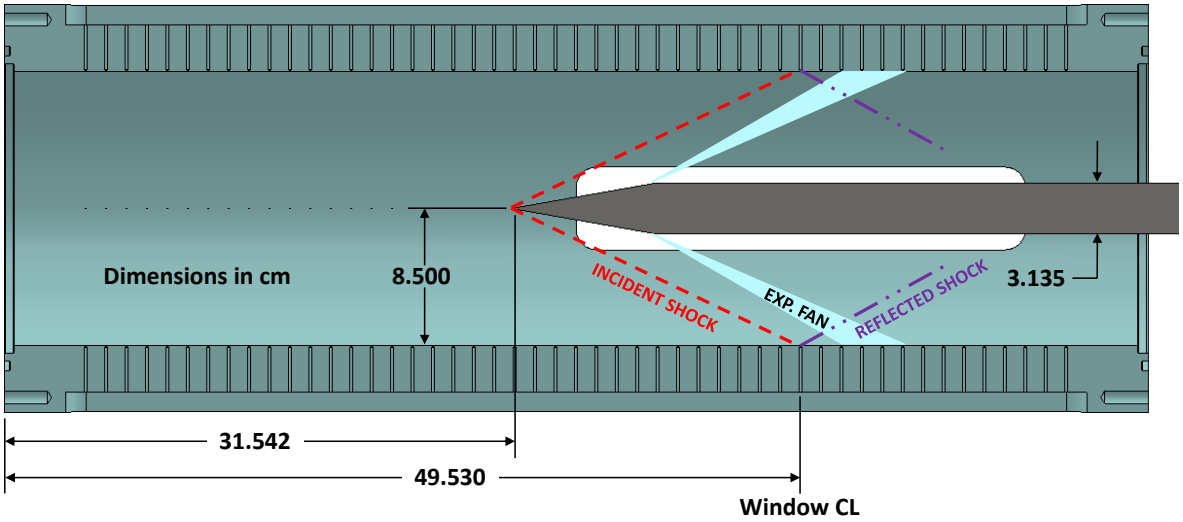


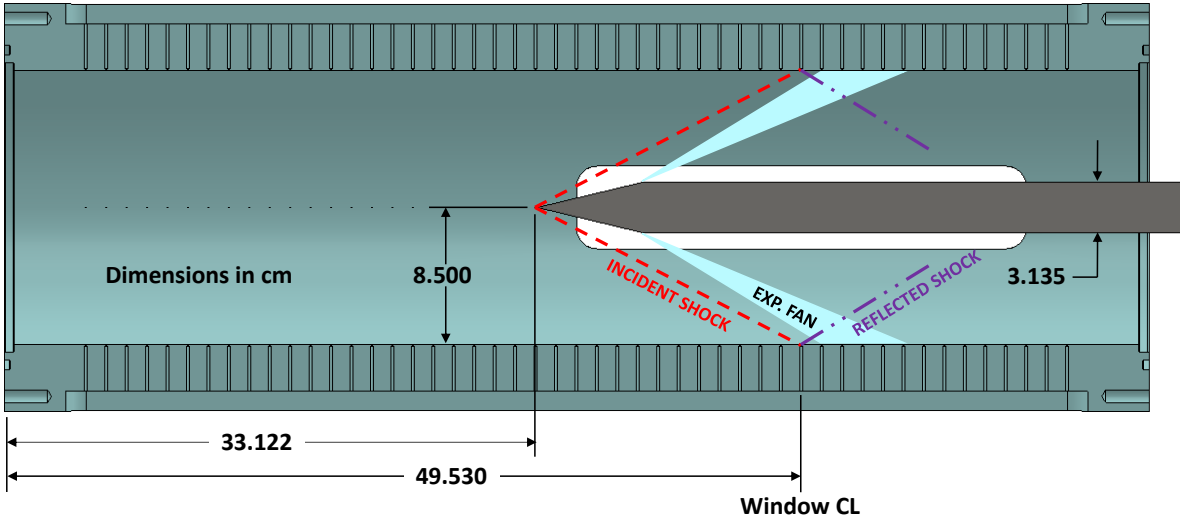


Shock Generator Assembly

- For the initial testing, two shock generator configurations were selected:

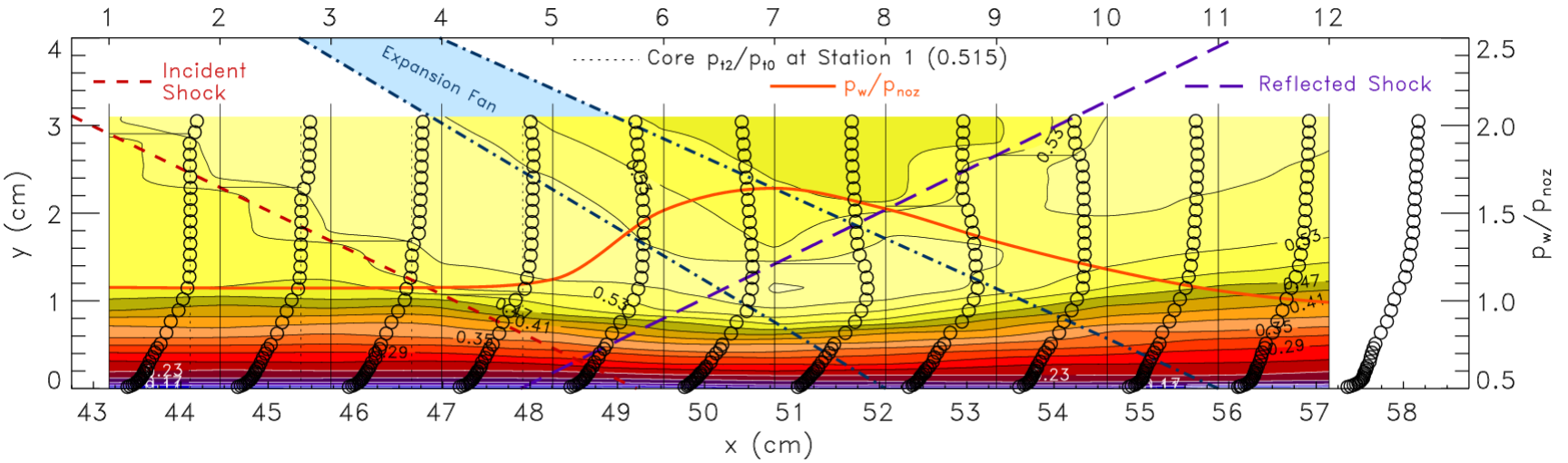
10.0° Cone
(Fully-Attached B.L.)



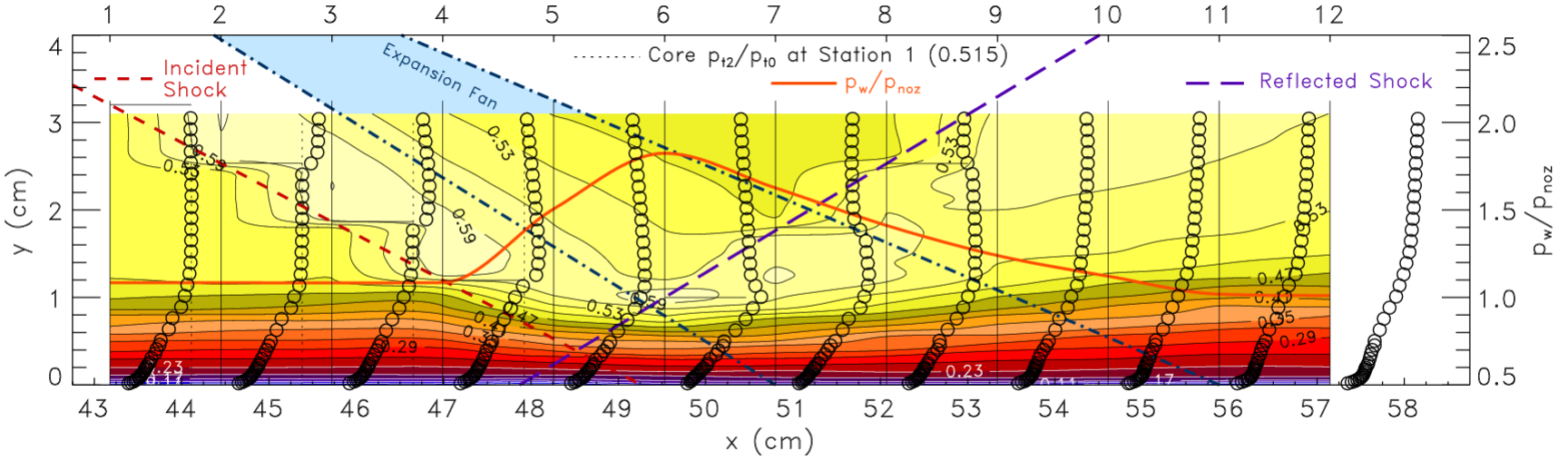


13.5° Cone
Incipient Separation

SWBLI Interaction, Pitot Profiles



α=10.0°

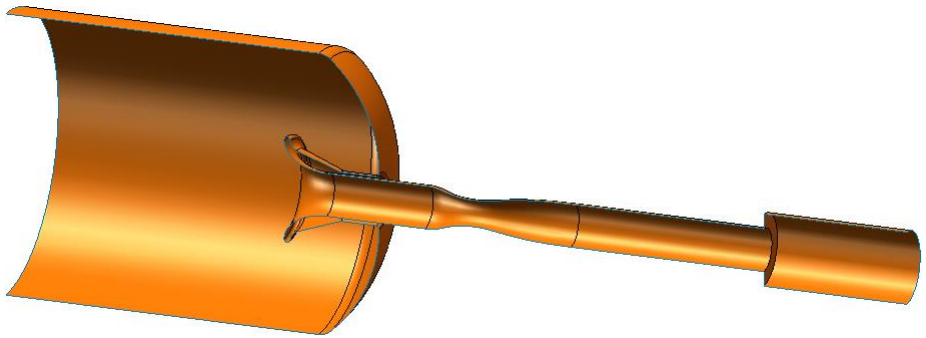


α=13.5°

Path Forward

- Dynamic Instrumentation:
  - Dynamic Pressure Transducers (Surface and Flowfield)
  - CTA and CVA Hot-Wire Anemometry (In Progress)
  - PIV (Under Development with Concerns)

- QUESTION: What data are of the highest value to code and model developers?
  - RANS?
  - LES?



Davis, D. O., "CFD Validation Experiment of a Mach 2.5 Axisymmetric Shock-Wave/Boundary-Layer Interaction," ASME Paper AJK2015-06342, ASME/JSME/KSME 2015 Joint Fluids Engineering Conference, Seoul, KOREA, July 26-31, 2015 (also NASA TM-2015-218841).